RIVETED GIRDERS.

BY ALBERT F. HILL, C. E.

The riveted girder may be properly considered the intermediate structure between the rolled beam and the framed truss; it finds its first application in those cases where either span, or load, or both, begin to exceed the availability of the rolled beam, and is often found to be preferable to the framed truss, where, from lack of room, we are obliged to make the ratio of the height of a truss to the span small, and where the load to be carried per lineal foot of structure is great, as, for example, in short span railroad bridges.

Considering the important part which plate girders have in our railway service, and that they necessarily partake of all the defects which riveted work in general is heir to, a few remarks in relation to the prevalent methods of dimensioning and manufacturing these structures will hardly require any apology.

Whatever method of calculation may be preferred by the individual designer, it will probably be conceded that no material error is committed by the conception of a plate girder as a truss in which the flanges perform the functions of the upper and lower chords respectively, the moment of the flange stresses resisting the bending moment; and in which the web members are so slight in the dimension transversely to the truss, that their other dimension fills the whole web, as represented by the web-plate, which has now to resist all of the shear.

In dimensioning the flanges for such girders the allowable safety strength of iron is in accordance with the service for which the girder is designed, variously fixed at from 12,000 to 8,000 lbs. for extreme fiber strain, but very rarely, if ever, is this variation of safety factor observed in dimensioning the web against shear. As a result of this, we find in many cases the web-plate made too thin —and though "stiffeners" may be introduced to prevent failure from side-buckling, they are no remedy for disproportionate pressure upon the rivet area, nor protection against the more rapid deterioration from rust of very thin plates.

The web-plate should be thick enough to resist the shear at the abutments, as well as compression at an angle of 45°, equal in amount at any section, to the shear at that section.

The experiments of Regnault, Wertheim, Spangenberg, confirmed by later experiments of Kirkaldy, Thurston and others, fix the ratio of shearing to tensile strength at $\frac{4}{5}$. A series of experiments made by the writer on iron plates intended for girder webs gave the average ratio $\frac{357}{443}$ or almost exactly $\frac{4}{5}$.

The determination of the thickness of the web will follow from the following considerations, viz.:

The horizontal stresses being proportional to the distance from the neutral axis, are less at every point of the web-section than in the outside fibers of the girder section, and therefore covered by the allowable strain. The horizontal shear H at any section x of the web is greatest at the axis, and designating by h the effective depth of the *girder*, we have

$$H = \frac{max.\ S_x}{h}$$

the horizontal shear per unit of height; and calling C the allowable tensile strength of plates, the thickness of the web b will be determined by the equation

$$b \times \frac{4}{5} C = \frac{max.\ S_x}{h};$$

$$b = \frac{5\ max.\ S_x}{4\ h\ C}. \quad (1)$$

a thickness sufficient to withstand the horizontal shear at every distance from the axis.

Since the horizontal shear at any section is equal to the vertical shear at that section, the thickness b of the plate will suffice for both horizontal and vertical shear at every point from the axis.

But since b, the thickness of the plate, is uniform in the same girder, therefore a constant, it only remains for us to see under what conditions the term $\frac{max.\ S_x}{C}$ will become a maximum.

Designating by w' the dead load per lineal foot and by w the live load by lineal of girder, we know that

$$S_{min.} = \frac{w'\ l}{2}; \text{ and } S_{max.} = \frac{(w + w')\ l}{2};$$

are the limiting values of the shearing stresses, and as the shearing stresses are always greatest at the points of support we shall obtain the greatest value for b by substituting $\frac{(w+w')l}{2}$ for max. S_x and making $C = 9{,}000$, we obtain by substitution in equation (1)

$$b = \frac{5(w+w')\ l}{8\ h\ C}; \text{ or}$$

$$b = \frac{(w + w')\ l}{14{,}400\ h} \quad (2)$$

for web-thickness against shear.

Equation (2) may be simplified by substituting the total depth of girder for the effective depth, making $h' = \frac{9}{10} h$, which gives

$$b = \frac{(w + w')\ l}{12{,}960\ h'} \quad (3)$$

Side-buckling has thus far eluded investigation, and it is doubtful if any increase in the thickness of the web-plate beyond that necessary to resist shear would be as good practice as the use of vertical angle irons as stiffeners.

Deserving of more attention though than any methods of calculations are the methods of manufacture adopted in so many shops for the turning out of riveted work. The writer has visited—and therefore speaks from personal knowledge—establishments engaged in turning out riveted bridge work, the entire plant of which would have hardly sufficed for an ordinary boiler repair-shop. When it is considered that very few companies think they can afford an inspector at works, that even the most concientious and strictest of inspectors could not watch the work so closely that no imperfection should escape him, that the very concerns who lack most in facilities for doing proper work are the very ones who are always ready to bid lowest, it is not to be wondered at that riveted work is being looked upon with more and more distrust.

In the first place, it will be found of very common occurrence that the holes of contiguous parts do not *match*. In order, therefore, to admit the rivets, the ever ready drift-pin, and, perchance, even the cold chisel are resorted to. Now when it is remembered what excessive distortion of fiber the punching causes anyhow, and that even the best mode of riveting—power riveting—also distorts and opens out the fiber in the rivets, it will be seen how necessary it is to avoid the development of initial strains, which are entirely beyond computation.

Fig. 1. shows the section of a ¾-in. iron plate, cut in the planer through the section of the rivet hole,

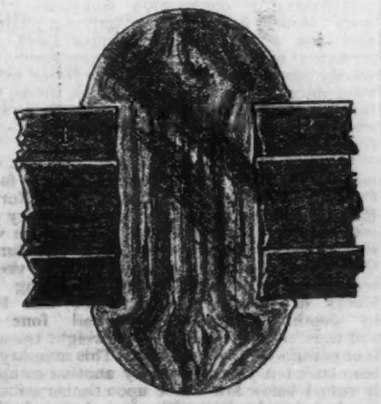

FIG. II.—IRON RIVET—PUNCHED HOLES.

the ends sheared off, and the planed surface treated with acid to develop the fiber. Fig. 2. and Fig. 3. are sections of rivets and plates cut in the planer and the rivet sections only, treated with acid. The rivets were driven by power—and carefully driven —yet the punched holes in the three contiguous plates (Fig. 2), although matching perfectly, show what distortion the rivet has undergone, and how far it is from "filling the hole." Fig. 3. shows the rivet driven through punched holes, enlarged by the reamer. The difference in the result is too striking to need much comment, beyond pointing out the inevitable distortion of fiber in the rivet, and the fact that the rivet seems to have shrunk from the hole. Out of 24 rivets, driven in drilled and in reamed holes, 17 were found, on cutting them out in the planer, to have sufficiently shrunk from the hole to admit of being taken by hand. These inherent defects in the best kind of riveted work are fully recognized abroad, and the best

FIG. III.—IRON RIVET—REAMED HOLES.

shop-practice there insists upon drilled holes in riveted bridge-girders.

This does away also with the separate laying out of the holes on each piece from wooden templates —the principal cause of the non-matching of holes

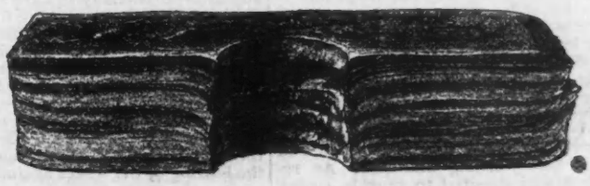

FIG. I.—SECTION ⅜-IRON, HOLE PUNCHED, ENDS SHEARED.

—since drilled holes admit of the assembling of the different parts by means of clamps, and the simultaneous drilling of the contiguous parts.

To show the relative influence of punching and drilling upon iron plate, the experiments made by the "Master Mechanics' Association" are given here:

Specimens 1.75 in. wide, ⅝ in. thick, diam. of hole, ¾ in.	Method of rupture.	Load per sq. in. of cross section.	Load per sq. in. of rivet cross section.
1. Entire plate	Plate torn.	60,000	
2. Plate with drilled hole	Plate torn.	50,470	
3. Plate with punch'd hole	Plate torn.	38,431	
4. Single riveted hole drilled	Rivet sheared.	47,000	53,550
5. Single riveted hole punched	Plate torn.	50,100	57,570

The bad effects of punching become still more noticeable in steel plates.

Experiments 4 and 5 show that the rivet in the drilled hole bore about 9 per cent. less than in the punched hole. This difference must be ascribed to the sharper sides of the hole, which exercise a cutting action. This is also shown by the experiments of Sharpe and Kirkaldy, in which the same rivets in a steel plate showed much less resistance than in an iron plate. Fairbairn confirms this, having observed that the rounding off of the edges in drilled holes gave an increase in strength of about 12 per cent., but in punched holes only 2½ per cent.

Considering all these defects in riveted work, especially such as is produced by the ordinary methods of manufacture, it becomes evident that engineers must rely more upon the standing, facilities, and grade of workmanship, of the concern from which they get riveted work than upon inspection. A neatly-formed rivet head tells no tale until the mischief is done.

Careful calculations, strict insistance as far as possible upon full compliance with specification, and 20 per cent. more factor of safety for riveted than for pin-connected work will probably prove the best protection against "unforseen accidents."

ENGINEERS' SOCIETIES.

THE INSTITUTION OF CIVIL ENGINEERS.

At the ordinary meeting on Tuesday, March 14, Sir. J. W. Bazalgette, C.B., Vice-President, in the chair, the first read was on "The Design of Structures to resist Wind-Pressure," by Mr. Chas. B. Bender. It was observed that wind-pressure was as often overrated as underrated. Instruments to measure the velocity and force of the wind were not very reliable, on account of the frequent change of direction of the wind, and of its action by sudden gusts, and not by mere statical pressure. The most trustworthy experiments, made with falling plates by General Didion, yielded pressures of 40 lbs. per square foot, on a test plate having an area of 10.76 square feet, for a velocity of 111 miles an hour. The size of the test plate was very material. Had Didion used plates 12 inches square, the pressure would have been only 32 lbs. The form of surface exposed to the wind was also of importance. Hollow cups experienced double pressures, cylinders only one-half of the test pressure, and there were forms which reduced it to less than one-fourth of that on a flat plate. Since hurricanes generally acted with great lifting power, in calculating the wind-pressure upon a structure, the most dangerous direction of the wind must be considered. For bridge floors wind coming from below at an angle of about 25° was the most trying. Now, assuming the wind to blow in this direction and a little from the side, the total opposing surface of a structure, having regard to the size, position and form of its members, and, in the case of railway bridges, carrying a light passenger train on the floor, must be considered. Engineering structures must be so built that there should not be any movement, either of shifting, turning on a pivot, or tilting of the whole structure. Further, lateral and transverse wind-bracing must not be strained beyond one-third of the calculated breaking strain. Since the horizontal wind-bracing might experience strains from the vertical loads those strains must be deducted from the specified maximum; and it would be found that for short spans there would remain available for wind proper, 5 tons, and for large railway bridges, 6 tons per square inch of lateral wind diagonals. The transverse bracing might be influenced by the vertical loads, and it must likewise be designed to stand strains arising both from wind and from moving loads. The wind-pressure of the top lateral bracing of a bridge had to be carried to the lower floor, and each end must be sufficiently strong and stiff. As regarded details it was essential to provide strong plates or pins for joint connections so as to absorb additional or secondary strains upon the members. In the case of eccentric connections, the moments of flexure arising from the application of forces must not be neglected, and there should be members strong enough to transfer the wind-strains to the central joint. Iron piers, also long-span bridges, must be carefully examined as regarded tilting, and the danger must be met by giving a sufficient base, or by anchoring to heavy blocks of masonry, well proportioned and well executed, or by both of these methods. The consideration of the action of wind materially influenced the proportion of the width of a bridge to its depth, and the latter was limited long before the maximum height was reached, as regarded vertical loads, in a bridge of most economical design. For instance, in a girder bridge of 400-ft. span and 18 ft. wide, the truss could not with safety be deeper than 45 ft.; if built 50 ft. deep, a width of 21 ft. was advisable. As the force of the wind upon a large railway bridge amounted to about the load of an ordinary train, it followed that its design for carrying vertical loads was only part of the problem to be solved. Bridges and similar structures, if equally well designed in both directions, horizontal as well as vertical, were satisfactory, and they would not be so unless this were done.

The second paper was read on "The Resistance of Viaducts to Sudden Gusts of Wind," by Prof. Jules Gaudard. In order to ascertain the stability of a structure exposed to wind, it was necessary to find the greatest pressure to which it might be subjected by sudden squalls. The maximum wind-pressure in England had been stated by Rankine to be 55 lbs. on the square foot, but a pressure of 71 lbs. was observed at Liverpool in September 1875. Tornadoes in America were reckoned to have exerted pressure of from 84 to 93 lbs., though allowance for pressures of only from 33 to 50 lbs. was made by American engineers in designing bridges. In order to procure more precise data, it was urged that suitable apparatus should be at once established, in various places, for recording the pressures attained during severe gales. Suspension bridges, owing to their flexibility were most affected by wind, as evidenced by injuries inflicted by gales on the Roche-Bernard and Menai bridges. This class of bridge had been stiffened by additional cables from the top of the piers to the roadway, by stays underneath, by cross-bracing between the suspension-rods, by stiffening the sets of chains themselves, or by spreading out the cables laterally at the tops of the piers. Thibault found that with two square screens placed at the distance apart of one of their sides, and one completely covering the other, the wind-pressure on the two screens was 1.7 of that upon the exposed screen. The pressure, however, upon two plate-girders connected by a platform was evidently less, and when the roadway was at the top or bottom of the girders might be reckoned as 1.2 of the pressure on the windward girder. In the case of trellis-girders, each opening might be regarded as an orifice with thin sides, in passing through which the stream of wind experienced a certain amount of contraction, which occasioned a somewhat greater resistance than the proportion of solid to open would indicate. An arch had the merit of opposing less surface to the wind in the central portion of the span; whereas, the reverse was the case with a bow-string. Two narrow iron-arched bridges of large span at Oporto and Montereale had been secured against the wind by special contrivances; the first, by spreading out the iron ribs toward the springings, so that the ribs, though only placed 13 ft. apart at the crown, were 49 ft. apart at the springings; and the second, by placing side buttresses against the haunches of the arch, thus providing a wider base. Trains passing along a lattice-girder bridge increased the surface exposed to the wind. In the case of high viaducts, the greatest strain was thrown upon the anchorage of the piers. The strains upon the Bouble viaduct, having lattice-girders and braced iron piers 189 ft. high, were investigated, and it was shown that in the extreme case of a wind-pressure of 55.8 lbs., and a train on the viaduct, a strain of 24⅗ tons would be thrown on the anchorage. The strain on the anchorage might be provided for, either by stays fastened near the tops of the piers and secured to the ground, or by widening out the base of the piers by buttresses. High timber stagings, with their broad surfacings, were specially exposed to damage from wind, but they might be effectually braced by iron wire cables. The force of waves, beating against very exposed structures, appeared occasionally to have attained a pressure of about 6,000 lbs. per square foot, but in general the shock of waves was estimated not to exceed from 600 to 1,000 lbs. Even with this latter pressure, the blow of the waves against the lower portion of a lighthouse was more to be dreaded than the pressure of the wind above, unless the tower was exceptionally high. On the contrary, in the case of a high viaduct, the effect of the wind on the lofty superstructure was more dangerous than the beating of the waves against the narrow piers.

AMERICAN SOCIETY OF CIVIL ENGINEERS.

The Society met at its house in Twenty-third st., New York, Wednesday evening, April 5, 1882, President Ashbel Welch in the chair. The following candidates were elected members: Lieutenant William H. Bixby, Corps of Engineers, U. S. A.; F. A. Calkins, New York: J. M. Knap, New York; Chas. P. Perkins, Williamsport, Pa.; B. Rhodes, Niagara Falls; Robt. Surtees, Ottawa, Can., and Associate Member, John Lockwood, New York. Arrangements were made for the annual convention of the Society, to be held in Washington, May 16, prox., and succeeding days. The introduction of a bill in Congress was announced for establishing a commission composed of persons skilled in the investigation, production and use of metallic substances and other structural materials. The great importance of the speedy passage of this bill to the future safe and economical construction of bridges, roofs, floors, iron or steel ships, ordnance and armor, and all structures in which metal is extensively used, was forcibly presented.

A paper by A. P. Boller, M. Am. Soc. C. E., on the Mode of Underpinning adopted for the Croton Lake bridge, New York City and Northern Railroad, during the repairs to the masonry piers, was read by the Secretary. This bridge was a single track, wrought-iron, deck structure in three spans of 160 ft. each, with skeleton wrought-iron piers or towers springing from blocks of masonry. The water was 30 ft. in depth. These towers had four legs and thus concentrated all the weight upon the four corners of the masonry. This masonry had been built ten years before by another company. It rested below low water upon timber cribs. It was tested by loading with stone before building the iron bridge, without showing improper settlement. The erection of the bridge towers and the use of the bridge soon developed the fact that the masonry could not stand the weight upon its corners, and it became necessary to rebuild it. The tower being continuous framework, with spreading legs, made it practicable to build inside of them a subsidiary wooden tower, with perpendicular legs. This was done, the bottom wood sills being placed so as to admit the introduction of eight 20-ton hydraulic jacks. Two-minutes' work with the jacks lifted the towers and adjoining spans bodily. They were then supported upon 15-in. rolled beams, 200 lbs. to the yard, placed in pairs, resting on the inner side upon timbers distributing the weight upon the masonry and on the outer side on timber supports built up from the original crib work. The defective masonry was then taken out and rebuilt. One-half hour sufficed to raise the structure, throw the weight upon the cross girders and resume traffic. No train was delayed on its schedule time. The author criticises severely the character of the old masonry.

The subject of the overflow of the Mississippi was also discussed.

A MODEL CITY GOVERNMENT.

If to love light rather than darkness is an indication of good conduct, the government of the city of Berlin must be excellent. Those to whom it is intrusted appear to take satisfaction in exposing their every act to the widest publicity. Account is rendered to the whole world of expenses and receipts to the last pfennig, of the motives which have guided the authorities in their past actions, of their future plans and of their methods, the names, addresses and functions of all concerned in the administration of the city are published, the citizens are instructed in the city constitution, the relations of city to state, and the changes which the city fathers think desirable.

In the "Personal-Nachweisung der Berliner-Gemeinde Verwalthung," information is given in the fewest words concerning the location, purposes and officers of every city institution, as well as the names and duties of all those who in any way take part in governing the city. It is to the city what a register or catalogue is to a university or college. Like the other publications of the city, it may be purchased of any book dealer for a moderate price. The director of the statistical bureau of the city publishes every year "Das Statistische Jahrbuch der Stadt Berlin." This contains the city's annals expressed in figures. It is to the city much the same as a well-kept diary would be to an individual, if the events it described were arranged and classified at the close of the year. It is a work of scientific value, which shows in a surprising manner how much useful, curious, and at the same time highly interesting information can be conveyed in tables of figures. But the most valuable of all the city's publications are the reports of the magistracy. Four of these reports have been published. The first, appearing in the year 1842, described the administration from 1829 to 1840; the second, appearing in 1853, embraced the years 1841 to 1850; the third, published in 1863, treated of the decade from 1851 to 1860. The fourth report is the one of which we shall treat in this article.

The preface to the Report on the Administration of the City of Berlin, from 1861 to 1876 inclusive, describes the motives which have led the magistracy to publish it. It is hoped that it will be useful to the authorities of other cities, inasmuch as it furnishes the means of comparing different methods of striving for the same goal. It aims, further, to instruct citizens and officers who have only lately begun to take a part in the government of the city, in the work which has been already accomplished by the several branches of the administration, and to point out clearly the yet unsolved problems which arise from the concentration of a great number of men within comparatively narrow limits. The concluding paragraph of the preface to the third volume shows how clearly the city fathers have conceived the central idea of good government, and how earnestly they are endeavoring to fulfill their duty toward the city. They state that they have written a report which will find, they trust, numerous readers among the citizens—those who are simply voters as well as office-holders—and will lead to a better understanding of municipal affairs in wide circles, since the success of the future administration of the city depends to a great extent upon the earnestness and intelligence with which the Berlinese interest themselves in city institutions, and the fidelity with which they discharge their functions as citizens. Such openness and honest sincerity on the part of city authorities impress one who, like the writer, is a New Yorker, with a strange feeling of unreality. In fact, in reading many parts of this admirable report, one finds it difficult not to believe that it is a description of some city government in Utopia. Can the New Yorker realize the fact that there is a city where the streets are kept clean at a moderate cost, and the work done between midnight and morning so as not to interfere with traffic; where snow and ice are removed from the highways thoroughly and with dispatch;* where the streets are well paved or are being paved, and in such solid, substantial manner that it seems as if the pavement must last for generations; where the city is well lighted without any gas-company quarrels; where

* The writer has already described the methods and expenses of street cleaning in Berlin in an article published in the *Evening Post*, April 6, 1881.

the city gas works are so well managed that they yield a surplus equal to nearly a tenth of the net revenue of the city from all sources; where there are no rings; where there are no defalcations or thefts on the part of city officials; where there are no fat contracts; where there are no street-paving jobs and no neglected parks? Although a New Yorker might smile incredulously at the statement, there are such cities, and Berlin is one of them. A study of the administration of Berlin may assist us in discovering means to abolish the misrule to which we are subjected.

It can scarcely be more difficult to govern New York than Berlin. Both cities are of nearly the same size and both have grown rapidly. In 1829 Berlin had a population of 242,000; in 1880 one of 1,118,630.—*The Nation.*

CORRESPONDENCE.

GRANITE PAVING BLOCKS.

ST. LOUIS, April 4, 1882.

EDITOR ENGINEERING NEWS:

SIR: On page III., No. 13, you give prices for granite paving blocks for Boston thus, 100,000 blocks at $45.93 per 1,000—or—100 000 at $49 per 1,000, etc. In connection with this information, it will be very interesting to learn something relating to the specifications for the blocks, as they cannot be expected to be all alike in size or shape. Boston specifications for preparing the bed of the street and putting down this kind of pavement will be read with much interest also.

[We insert the above trusting that some of our Boston friends will supply the needed information.]

THE OUTLOOK FOR ENGINEERS.

RICHMOND, Va., April 4, 1882.

EDITOR ENGINEERING NEWS:

Upon my arrival in this city, a few days ago, I received, with great pleasure, from home, ENGINEERING NEWS for March.

On reading the article of the 18th on the "Outlook for Engineers," and your advice to go South, thinking that some worthy members of the profession may be misled by it, I can't refrain giving them, through your paper, my observations upon the subject.

After an extensive tour over the section, I find there a great many competent and experienced native-born engineers ready and willing to take hold of any kind of work, and it would be next to impossible for a Northern engineer to get city work, as politics come in play there; so railroad work is his only hope, and then he must get his appointment through some stockholder of a road in the South, at home. Most of the engineers from the North that I have met are of this class, and I am told by an old friend here that in this way, in the last year or so, young and totally incompetent men have been put in responsible positions in this State, and that they have made sad failures, which have brought great discredit upon the whole profession.

It is very evident, as you say, that a man would have to "pay out a good bit" and diet his stomach a great deal before he could locate.

Yours truly, B. K. SMITH, C. E.

SPIRAL CURVES.

RICHMOND, Ind., April 3, 1882.

EDITOR ENGINEERING NEWS:

DEAR SIR: If it will not tax the patience of your readers too much, I should like to say a few words more on the above subject.

It is now about thirteen years since I took my first lesson on the section, and now have charge of the repairs and improvement of over 400 miles of road; but I never had a firmer belief in the value of easement curves than I have to-day.

About 30 years ago a piece of road about 80 miles long was constructed. The assistant in charge of the field work, now a well-known chief engineer, worked out a formula for an easement curve which he used. About ten years later 50 miles were built on the end of this piece, and only circular curves were used. It has been a fact, acknowledged by all familiar with this track, that the curves on the first piece ride the best. Within the past two years part of both of these pieces have been relaid with new steel and stone ballast put in. When this was done, the lines were all rerun; and, although the curves were very long, and the tangents short, and the spiral slightly different from the original ones on the first piece, the new centers agreed very well with the track, and showed both circles and spiral nearly in their original position, while in many cases of circles alone it was necessary to resort to "heroic treatment" to bring them to shape.

My observation leads me to believe that a curve laid with steel, having good splices resting on a good road-bed and ballast, if kept well tied and constantly to gauge and in good surface, can be kept very nearly to its original alignment during the life of a good steel rail.

Yes, Mr. Editor, I believe that the very little extra work required to lay out spiral curve is well spent, and I believe that the best way to keep good track is to have it put in the best possible shape in the beginning and each time new rail is laid by the best extra foreman obtainable. The section foreman will then, if he has any pride, try to keep it in at least as good condition as when he receives it. Yours truly, ENG. M. of W.

THE METRIC SYSTEM.

ABBREVIATIONS.

BOSTON, April 3, 1882.

EDITOR ENGINEERING NEWS:

The report of the Metric Committee of the Boston Society of Civil Engineers, dated Feb. 15, 1881, contained, among other valuable matters, an important table of metric abbreviations which, "initiated by the Swiss government, and approved by the government of Italy, has been decided upon by the International Committee of Weights, sitting at Paris." The *Bulletin du Ministre des Travaux Publics* and some other French publications adopt it.

This table of abbreviations is unfortunately incomplete, being limited to those denominations most in use, omitting ten which are by no means obsolete, although less frequently used.

It being important that the entire series should be complete, these ten denominations have been inserted in the table below, with abbreviations recommended by the American Metric Bureau, and in keeping with the others. They are marked with an asterisk to distinguish them from the original series.

The abbreviation *dal.*, adopted by the Paris Committee for the word *dekaliter*, was derived from the French spelling, *deca*. This has always been a source of confusion from its resemblance to *deci*; the *a* being the only distinguishing letter. To avoid this, the spelling *deka* has been adopted by high authority. The committee who reported upon the most proper spelling of the metric nomenclature, said in their report:

"In the prefix *deka* the *k* is used because of the great danger of confusing *deca* and *deci;* besides *deka* is a much better spelling in itself, as there is no danger whatever of mispronunciation; and the *k* is more nearly in harmony with the Greek *kappa*, although that letter is so often represented by *c*. This is in accordance with the government reports of Germany, England and the United States."

The abbreviation *dk.* for *deka* is therefore preferable, and best adapted to the practice of the three countries mentioned above. It is, moreover, more suggestive of the word itself. The abbreviation *dkl.* has been placed accordingly in the table by the side of the form adopted by the Paris Committee.

The table is as follows:

LENGTH.	
*Myriameter	mym
Kilometer	km
*Hektometer	hm
*Dekameter	dkm
Meter	m
Decimeter	dm
Centimeter	cm
Millimeter	mm
Mikron (0.001 mm.)	μ
SURFACE.	
Square kilometer	km^2
Hektar	ha
Ar	a
*Centar	ca
Square meter	m^2
Square decimeter	dm^2
Square centimeter	cm^2
Square millimeter	mm^2
VOLUME.	
*Dekastere	dks
Stere	s
Cubic meter	m^3
*Decistere	ds
Cubic decimeter	dm^3
Cubic centimeter	cm^3
Cubic millimeter	mm^3
CAPACITY.	
*Kiloliter	kl
Hektoliter	hl
Dekaliter	dkl or dal
Liter	l
Deciliter	dl
Centiliter	cl
WEIGHT.	
Ton	t
Metric quintal	q
*Myriagram	myg
Kilogram	kg
*Hektogram	hg
*Dekagram	dkg
Gram	g
Decigram	dg
Centigram	cg
Milligram	mg

A joint committee of the American Metric Bureau and the American Metrological Society recommended a system of abbreviations in the year 1877, which has been extensively used in this country. It differs very little from the above table, except that the measures of volume are omitted, and the measures of surface are less in number.

The system is as follows:

"The initial letter should be used for each word; *m*, *a*, *l*, *g* for the units; *d*, *c*, *m* for the divisors; and the capitals *D*, *H*, *K* and *M* for the multiples. The kilogram is almost universally called simply the *kilo*, and is abbreviated K."

The slight difference afforded by the use of capitals and small letters has been found to be an insufficient distinction between such similar words as *deka* and *deci*, or *myria* and *milli*, and the forms given in the table are now preferred.

SQUARE AND CUBIC MEASURES.

Surfaces and volumes are usually measured by the squares and cubes of the measures of length.

All the measures of surface, the square myriameter, the square kilometer, etc., down to the square millimeter, being each 100 times greater than the one which comes immediately below it, care should be taken when expressing them in figures to reserve *two* places for each unit of measure.

Thus 1 m^2., 1 dm^2., 1 cm^2., 1 mm^2., is written
1.010101 m^2.
15 m^2., 8 dm^2. is written
15.08 m^2.
37 m^2., 6 dm^2., 62 mm^2. is written
37.060062 m^2.

When reading a number comprising an odd number of decimal places, a zero may be mentally determined at its right hand, thus 6.066 m^2. may be read
6 m^2., 6 dm^2., 60 cm^2.; or
6 m^2., 660 cm^2.

The number 20,202,020,202 mm^2. when divided into its component denominations may be read
2 hm^2., 2 dkm^2., 2 m^2., 2 dm^2., 2 cm^2., 2 mm^2.; or
20,202 m^2., 2 dm^2., 2 cm^2., 2 mm^2.

The same principle applies to the units of land measure.

Thus 7 ha., 7 a., 7 ca. may be written
7.0707 ha.

The ordinary method of expressing areas of land, however, is to state them in terms of hektars and square meters. The above example would ordinarily be written
7 ha. 707 m^2.

The three special denominations of land measure, the *centar*, *ar*, and *hektar*, are in strict accord with these properties of the squares of the linear measures, because they are merely other names for the square meter, the square dekameter, and the square hektometer, respectively. The two intermediate denominations, required by a strict conformity to the nomenclature of the system, the *deciar* and *dekar*, have not been used, because the sides of the squares which they represent, having areas of 10 and 1,000 square meters, respectively, cannot be exactly expressed in terms of the linear measures.

Similarly, the measures of volume, the cubic meter, the cubic decimeter and the cubic centimeter, being each 1,000 times greater than the one which comes immediately below it, care should be taken when expressing them in figures, to reserve *three* places for each unit of measure.

Thus, 1 m^3., 1 dm^3., 1 cm^3., 1 mm^3., is written
1.001001001 m^3.
3 m^3., 82 dm^3., 7 cm^3., 56 mm^3., is written
3.082007056 m^3.

The number 3.1476 m^3. may be read
3 m^3., 147 dm^3., 600 cm^3.,
two zeros being mentally supplied at the right.

These principles, which are merely an application of the laws of decimal numbers, may he illustrated thus,

The number 82.35, if representing *meters*, may be separated into four denominations,
8 dkm., 2 m., 3 dm., 5 cm.,
each composed of a *single* figure.

The same number *squared* gives 6781.5225.

This, if representing *square meters*, may be divided into four denominations,
67 dkm^2., 81 m^2., 52 dm^2., 25 cm^2.,
each composed of *two* figures.

The same number *cubed* gives 558458.377875, which, if representing *cubic meters* and reduced to its component denominations, gives
558 dkm^3., 458 m^3., 377 dm^3., 875 cm^3.,
each composed of *three* figures.

The long decimal fractions resulting from the continued multiplication of numbers, which often lead to a vague and indefinite impression on the mind, assume a very precise and definite character when separated into the squares and cubes of the linear measures; the decimal nature of the metric system rendering this separation possible by simple inspection.

The cubic denominations comprising the *stere* and its derivatives are exceptions to these principles, only one of them, the *stere*, which is another name for the cubic meter, being an exact cube of a linear measure. They progress by a 10-fold ratio, and only require a single place for each denomination. Their use should be restricted to merchandise, which is sold in small quantities by cubic measures.

By the present practice they are used only in the measurement of wood.

CHARLES H. SWAN, C. E.
Chairman Committee on Manufactures, American Metric Bureau.

ENGINEERING NEWS.

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SATURDAY, APRIL 8, 1882.

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Correspondence upon subjects which naturally belongs to the province of this journal is solicited.

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MISSISSIPPI RIVER FLOODS.

The late tremendous floods on the Mississippi River and the devastation and suffering created thereby have very naturally brought up the inquiry as to the proper means which the general government should exercise to prevent their recurrence, or to mitigate their violence, for it is out of the question to suppose that the respective States through which the river passes can effect anything of practical value to that end. This has naturally brought forward individual schemes and projects, which are urged upon Congress with the persistency peculiar to our American politics, and everyone who has seen water run down hill thinks that he could offer some advice of value to the authorities. The interest at stake has become so vast by the increasing settlement of the Mississippi valley that the plans to be followed for the improvement of its navigation and the protection of the delta from overflow have become subject of bitter controversy. A Mississippi River commission, of which Gen. Q. A. Gilmore is president, composed of three United States engineers of high rank, three civilians of experience in connection with the subject and an officer of the coast survey have been for some time (three years) charged with the operations under the U. S. government on the river, embracing in their duties, of course, the preparation of plans for its permanent improvement. This board have from time to time made reports of progress, and appear before the committee of Congress when called upon, in relation to the subject matter, and their views are strongly antagonized just now, by some prominent individuals supposed to know something of the subject, who are desirous of securing appropriations to carry out their own views, or at all events, to experiment with the government funds in opposition to the projects of the commission.

It is well known that millions of acres of highly productive land are now under the flood-waters of the lower Mississippi, and to the inexperienced eye it would very naturally appear that, if the river had more outlets from the flooded district to the Gulf, to allow sufficient escape to this piled up water, permanent relief from the evils of a flood would be secured. The arguments of the opponents of the River Commission take about the following shape. If we bore two holes in a tub of water it will flow out faster, and its surface will be lowered more rapidly than with one. If we can tap a river with outlets along its course, a greater avenue of escape will be provided for its flood-waters, and they will rise to less height. The Mississippi from Red River, three hundred miles to its mouth, flows along the summit of a ridge, whose sides slope away to the Gulf. These slopes are intersected by bayous. If we open up the head of these bayous to the river, thus furnishing outlets for the surplus waters, we lower the flood heights. This, they say, is the experience of crevasses. The current will be quickened above, the bed scoured out and the waters lowered within the banks. This would seem to be in accordance with common sense and presumed facts in the case, and would be true of the Connecticut, Susquehanna and other rivers, and why not true of the Mississippi? And yet it is not true of this river. The commission of hydraulic experts, men who have no purpose in view but their duty in the premises, and actuated solely by their sense of what is right, and the desire to sustain their professional reputations, most unqualifiedly allege, that "no surer method of ultimately raising the flood surface of the river can be adopted, than by making lateral outlets for the escape of its flood-waters," and sustain this view by experience derived from the action of this river, as well as all other rivers of *like character*. This latter circumstance it is important to bear in mind. The immediate effect of a crevasse during flow, is the reduction of the height of the surface of the river in its vicinity, and below it, and lateral outlets, either natural or artificial, by which the flood-waters of the river are drawn off and conveyed through a shorter route to the sea, would tend to prevent the recurrence of destructive floods by supplying additional avenues of escape, but for the fact that the flood-waters of this river are highly charged with sedimentary matters held in suspension by the current alone, and to transport this matter to the Gulf, the velocity of the current must be sustained. The action in the case of a crevasse or of a lateral outlet to the river at flood, is as follows: As a portion of the volume of the river is drawn off by the crevasse when it is first made, it is impossible that the current below the crevasse can be then as rapid as it was before its occurrence. Being less rapid, it is unable to sustain the whole quantity of matter held in suspension by the more rapid current above the outlet, and consequently its surplus sediment falls to the bottom below the crevasse, and a shoal is commenced, which, if the crevasse remains open for any length of time, will continue to extend down stream. This deposition will continue until the size of the river below the crevasse has become so reduced by the shoaling that the current is restored through the short distance in which the bottom of the river has been thus raised and its channel way diminished; but the reduced velocity will still exist in the river below the shoal. As the volume flowing in the river below a crevasse is decreased by the amount drawn off through the outlet, a steeper slope prevails for a distance, because the shoal below the outlet, as it grows in length down stream from the deposition of successive flows, gradually increases the frictional resistance of the volume flowing through that diminished channel, and with an increased head checks the current of the river above and raises its level; and thus the shoaling of the river bed and the raising of the flood line *above* the site of the outlet ensue as a permanent effect. Wherever such stream flows through alluvial deposits, other conditions being the same, the surface slope is least where the volume is greatest, and conversely the surface slope is found to be invariably increased as the volume is diminished. The Mississippi throughout its alluvial basin, not only in its main trunk but in all of its outlets, presents no exception to this peculiar feature, and the U. S. Mississippi River Commission summarize these principles briefly and comprehensively as follows in their report to the Secretary of War:

"If the normal volume of water in a silt-bearing stream flowing in an alluvial bed of its own formation be permanently increased, there will result an increase of velocity and consequently of erosion and silt-bearing power, an increase in area of average cross section, and an ultimate lowering of the surface slope; and conversely, if the normal flow be decreased in volume, there will ensue a decrease of velocity, silt-transporting power, and mean sectional area, and an ultimate raising of the surface slope." So that however paradoxical it may appear, opening outlets for the flood waters of the lower Mississippi to the Gulf will ultimately increase the height of the flood levels.

SANITARY.

We have taken occasion to comment upon sanitary matters from time to time, and we are desirous that the NEWS, while not an organ of sanitary engineering as a specialty, and committed, indeed, in opposition to much that has been advanced as sanitary science, shall yet be fully recognized as advocating all true progress in the direction of reform and improvement in this most important branch of engineering art, and to be fully understood in this connection we make this announciation—that, in view of the resources of modern art, there is nothing which adds to the real home comforts of life which may not be made perfectly safe and as conducive to health as to comfort. We are induced to touch upon this subject as much misapprehension exists as to the dangers to health of what are called modern improvements in housekeeping, and it is becoming to be considered the right thing to forego some of the luxuries of living, which a few years of use had taught us to consider as necessaries. If foregoing these luxuries consisted in reducing the expenses of living this would be a wholesome return to first principles foreshadowed, but, on the contrary, what every one can enjoy ceases to be regarded as a luxury, and, with the rubbish from our grandmother's garret as ornaments, we must adopt certain of her modes of living, not as we really believe because of their merit in themselves, but with the present craze in this direction it is fashionable to believe so; and the unfashionable masses in great cities in the first place have no grandmothers to inherit from, and, secondly, they couldn't in large cities afford the expense and inconvenience of adopting the comparatively simple and cheap conveniences of their forefathers, these conveniences having become a luxury which none but the well-to-do can afford. We copy from a daily paper the following: "In a carefully prepared essay on the drainage question, by Dr. Hamilton, of New York, he makes these suggestions for the benefit of those who expect to build, and are now troubled by sewer-poison. First, he would have all plumbing having any direct or indirect communication with sewers, excluded from those portions of our houses which we habitually occupy—in other words, placed in a separate building or annex. In the second place, the doctor urges that we return to the open-air fire-place, or the grate, as a means of warming our houses, and, in the third place, he calls for a diminished consumption of oxygen by gas-burners. It is still an open question, whether we shall be able to light our dwellings with electricity, but so long as we are obliged to depend upon gas, we must content ourselves with light, and not illumination. The concessions demanded are named in the order of their importance. The necessity for each is said to be urgent, *but the first admits of no compromise.*"

The director of the New York State Surveys, a member of the State Board of Health, says in his report to the board that he is "convinced that both in England and America, large combined sewers for carrying storm-water and sewage are, *and necessarily must be, constant and powerful sources of disease*," and the Board of Health, adopting his views, condemn them and recommend the separate system of small sewers with flushing-tanks for general use in this State.

Admitting that house plumbing, as usually practiced, is defective, would it not be more sensible and more in accordance with modern requirements to endeavor and perfect the processes now in use, rather than, on the supposition that it is as perfect as can be made, banish the pipes from the living house into an annex, not always to be had at reasonable expense or in crowded localities? If freedom from preventable disease is only to be had by such householders as can afford to have their plumbing separated entirely from their living rooms, under what circumstances are the masses of our citizens to live? Would not a system of piping of better materials and workmanship, and subject under law to periodical inspection, be a simpler method of improvement than the one suggested by Dr. Hamilton? Must we accept as gospel truth what one class of specialists assert as to the permeability of cast-iron pipes to the passage of air (for we are told by Mr. Gardiner that there is no such thing as sewer gas), and the slight impediment which the best water traps interpose to the passage of disease germs, and reject the experience of another class equally entitled to confidence, who deny the possibility of the latter occurrence and challenge any one to the proof? Whoever has any knowledge of ordinary plumbing may rightfully conclude that the practice of the art has not as yet exhausted all the means which are at command for the exclusion of poison from our dwellings.

With regard to the open fire-place, it is undoubtedly a luxury, which all who can afford to avail of should understand the sanitary advantages of, but those whose circumstances forbid its use for house warming, need not suppose that they are thereby given over to irremediable disease and death. There is nothing more certain than that dwellings may be efficiently warmed and ventilated with perfect safety to health by far less expensive methods than by open fire-places.

With reference to the use, or rather misuse, of gas. Such of our readers as have visited the homes of the nobility abroad or their palaces, have noticed the almost universal exclusion of gas and the use, instead, of candles. But this is not on the

score of health, but as being more expensive is less plebeian and more elegant, and borders on the ostentatious, as would the use of hickory wood fires for warming a gentleman's house in New York City. If the products of combustion are carried off as they may be by a comparatively inexpensive arrangement, there is no necessity whatever for depriving ourselves of so simple and convenient a method of lighting our dwellings.

That the larger sewers of the combined system "*must* necessarily be constant and powerful sources of disease" we deny. The grounds for the assertion rest upon the supposition that the ordinary flow through them is a "mere trickling thread," whereas the means exist for insuring at the low flow precisely the same form and dimensions of channel as that afforded by the separate system, and were this not the case the 20 or 30 gallons of liquid per capita, which in the older countries is all that they can afford, is usually quadrupled by the more liberal water supply demanded in our cities, and this increased use of water leads Mr. Gardiner to admit that the Memphis main sewers are thereby gorged and back up the sewage in the lower district, the sole remedy for which he states is, "that they be duplicated or rebuilt on a *larger* scale!" The cost and royalty on the patent flushing-tanks, rendered necessary by this system, and the use of which is recommended by the N. Y. Board of Health, even supposing they were a reliable means in all cases, would exceed in a city like New York that of a system of pumping salt water in times of drought into the summits of all the sewers (were the fresh-water supply inadequate in volume), and thus at all times insuring a gravitating current toward the outlets sufficient to prevent any deposit whatever in them.

The tendency of the "traveled" sanitarian is to base his conclusions on the obvious defects of old practices, which are still hampered with antiquated forms and methods of construction, and not under the fostering care of the inventor or his friends, and comparing them with recent works of small range, and which are still in the domain of experiment, his conclusions are necessarily of the nature of hasty generalization; the field of his observations embracing but the obvious defects of the prevailing method in use, and giving undue weight to the anticipated benefits to be derived from the substitution of another. Ill constructed works of sewerage soon become a nuisance, let the principles of their construction be as sound as they may. And as a hydraulic machine to effect a given purpose, any system of sewerage requires periodical inspection, repair and renewal, and to condemn a system as Dr. Hamilton has done, which, theoretically and practically, has been shown capable of great results, *when properly carried out*, because of its presumed danger to life and health when its true principles are neglected, is as absurd as to condemn the use of steam navigation because a neglect of proper precautionary measures may lead to disaster and death. Poisons cannot be eliminated wholly from the economy of nature, but they admit of such ready management through dilution that they may be rendered wholly innocuous. To this end, copious air and water supply, and the machinery through which this is best secured being fully up to the standard now required in all mechanical arrangements of importance, will secure all needed immunity from the dangers which may be supposed to lurk in home comforts.

WATER CONSUMPTION OF CITIES.

From a late report of the Purveyor of the Department City Works, Brooklyn, on an estimated population of 560,000, the consumption of water per capita was 58.44 gallons, distributed under the following items:

	Gals.
Used as determined by meter measurement, per capita	2.31
Estimated on basis of figures used in 1880, per capita:	
Manufacturers and others not metered	5.00
Domestic use	20.00
Private stables	2.00
Street sprinklers and street washers	1.50
Flushing sewers	.50
Drinking hydrants and fountains	5.00
Leaks in mains	2.00
Fire purposes	2.00
Waste	18.13
Total	58.44

The percentage of waste to the total consumption is stated as being 6.86 per cent. less in 1881 than in 1880. It is not stated how this waste is determined nor how the item of leaks in mains was arrived at, but we presume that these were matters of approximation merely.

SPRINGFIELD WATER SUPPLY.

From the Report of the Water Commissioners of the City of Springfield, Mass., we learn that the water in the Ludlow reservoir had become so offensive that many citizens resorted to pumps and such other sources as could be had rather than to use it. Various schemes from outside parties had been advised to overcome the difficulty; among others, that the water should be skimmed and strained; another that the river should be deepened on its shores, and the bottom cleaned from impurities.

The commissioners thought that the cause should be first ascertained before essaying to cure the evil. To this we agree, and when one considers the possible extent of the evil, economy would certainly point in that direction. The reservoir is *seven* miles in circuit, some 450 acres in area, and, according to the commissioners' statement, contains two *billion* gallons.

SEWERAGE OF CITY OF PHILADELPHIA.

The National Board of Health, in a supplement, publish a report of Engineer Wm. H. Baldwin, assistant to Geo. E. Waring, who in the summer of 1881 made a personal examination of the sewerage system of that city. The sewers are described as being built on the plan of forty years since, with dry bottoms, and the connections are frequently made by simply knocking a hole in the sewer, and inserting the branch pipe, piling up brick, earth and stone, and leaving it to take care of itself—poisoning the earth around it, and ultimately resulting either in the sewer caving in, or becoming stopped by the earth above the connection. The entire system, both of construction and maintenance, is not merely faulty, but vicious in the extreme; and were the death rate of the city a high one, there would be no difficulty whatever in sanitarians tracing it to its source. But here comes the anomaly—the death rate, not unfrequently, it is said, falls below 18 to the 1,000, a rate lower than any other large city with which we are acquainted!

Mr. Waring cannot explain this low death rate by attributing it to the large water supply, together with the "combined" system of sewers in use, but ascribes it to the fact, "that the poorer classes are not so crowded together, as in New York and other large cities." If our readers in this connection will please refer to what we have said in another column under the head of "Sanitary," they will appreciate the scope of our remarks wherein we maintain that there is something beyond the mere fact of a sewer being of large size for the reception of storm waters, and built of brick, which influences the spread of disease germs from sewer air; and in truth, how little the system of sewers alone has to do with the death rate in our cities.

PERSONAL.

T. A. HILL is chief engineer of the Austin & Northwestern Railroad, with offices at Austin, Tex.

T. M. JACKSON, chief engineer of the Kingwood Railway Company has commenced the work of locating the line. The headquarters of the company are at Kingwood, W. Va.

GENERAL GEORGE THOM, Colonel of United States Engineers, has been confined to his house at Portland, Me. His physician gave a prescription, and the druggist's clerk, by mistake, put up the wrong medicine, which nearly proved fatal. Antidotes were promptly administered, and he is now quite comfortable.

GENERAL DE FUNIAK'S duties as General Manager of the Louisville & Nashville, and President of the Pensacola & Atlantic, have forced him to resign his position as Chief Engineer of the Henderson Bridge Company. He will be succeeded by F. W. Vaughan, now Consulting Engineer of the same company.

HONORS TO AN ASTRONOMER.—The Academy of Sciences, Paris, has lately awarded the Valz Astronomical Prize to MR. DAVID GILL, Her Majesty's astronomer at the Cape of Good Hope. Mr. Gill has devoted his time most energetically for many years past to researches on the distance of the sun, and it is in recognition of this service that the award of the Valz Prize has been made to him—especially in consideration of his observations of Mars, at the Island of Ascension, in 1877, as discussed in a recent volume of the Memoirs of the Royal Astronomical Society. The committee was of opinion that the expedition to Ascension was fully successful, as Mr. Gill obtained twenty-two series of observations of the planet, each of which gives a value of the parallax of the sun; and the value resulting from a combination of all these was considered one of the most exact yet obtained. The astronomical prizes offered by the Academy for the present year are the Lalande and the Valz prizes, and a renewal of the Damoiseau prize, 10,000 francs in value, for a review of the theory of the satellites of Jupiter—this subject having been first proposed in 1869, and renewed four times since, no memoir having so far been presented to the Academy which could be regarded as meriting the award.

THE UNIVERSITY OF MICHIGAN.—The total number of students in attendance at the University of Michigan this year is 1,534, just the same as the total given in the annual calendar for 1880-81. Compared with last year, the Department of Law and the School of Pharmacy have made slight gains. In no department has there been any material loss. In point of numbers this university has risen rapidly, till it now holds the leading position among the higher educational institutions of the country. Organized and conducted primarily for the purpose of meeting the wants of citizens of Michigan, it pursues a wise and generous policy toward students coming from other States and countries. At the present time only forty-five per cent. of its students have their homes in Michigan. The number of women in attendance is about one hundred and eighty, or nearly twelve per cent. In the department of literature, science, and the arts, or, it might be called, the collegiate department, students are allowed a wide though not unlimited choice of studies. The aim appears to be to secure the benefits and to avoid the dangers of the elective system by prescribing a part of the work to be done by the candidates for the several literary degrees, or by requiring the student to elect a specified amount of work from limited groups of studies. The announcement of the organization of a School of Political Science, and a description of some of the studies to be pursued in the School, appear for the first time in the calendar for the current year.—*The Nation.*

PIERRE LE PLAY.—A dispatch from London announces the death on the 6th of Pierre Guillaume Frederick Le Play, a distinguished French engineer and writer upon scientific subjects. M. Le Play was born in Honfleur, April 11, 1806. In 1825 he became a student in the Polytechnic Institute. Later on he entered the department of mining engineering, and pursued the different courses until he became a chief engineer of the first class. After finishing his studies M. Le Play contributed a number of papers to various scientific journals, which attracted considerable attention and helped to secure for him a Professorship in the School of Mines, where he was put in charge of the inspection of studies. In 1853 he was appointed a Commissioner-General of the Imperial Commission which had charge of the preparations for the French Industrial Exposition of 1855. He became President of the commission and performed the arduous and important duties of that position so well that he received the title of Counsellor of State in December, 1855. At the London Exposition of 1862 M. Le Play attended as the representative of the French government. Five years later he presided at the opening of the Universal Exposition of 1867. In December of that year he was made a Senator. M. Le Play received many decorations as a member of foreign orders. On the 15th of December, 1855, he became a commander of the Legion of Honor, of which he was made a grand officer in June, 1867. He was the author of a large number of scientific works and memoirs.

MAJOR CHARLES W. HOWELL, of the United States Engineer Corps, died in New Orleans, on the 5th, of consumption, at the age of 40 years. He was a native of Indiana, and was appointed from that State to the United States Military Academy at West Point, being graduated seventh in a class of 25 in the Class of '63. On the day of graduation, June 11, he was appointed a First Lieutenant of the Corps of Engineers, and at once entered upon duty in the war of the rebellion, being attached to the Engineer Battalion of the Army of the Potomac. There he remained until May 25, 1865, when he was transferred to the Engineer Battalion stationed at Willett's Point, N. Y., remaining on service there until September of the following year. During his active service with the Army of the Potomac he participated in the Pennsylvania campaign; in the Rapidan campaign, commanding a company of Engineers at that time; in the action of Rappahannock Station, November 1863; the Mine Run operations, Nov. 26 to Dec. 3, 1863; in command of an engineer company in the Richmond campaign from May 4, 1864, to Feb. 16, 1865; engaged in constructing and dismantling bridges, making roads and reconnoissances, sapping and erecting defensive works on the march to the James River, May 4 to June 15, 1864; the action near Cold Harbor, and participating in the siege of Petersburg, from June 17, 1864, to Feb. 17, 1865. While operating before Petersburg he was successively breveted Captain and Major for the gallant and meritorious services during the campaign from the Rapidan to the James, and in front of Petersburg. Subsequently he served in the raid on the Welden Railroad, in the actions and operations about Hatcher's Run in the pursuit of the rebel army, April 3-9, 1865, and at the capitulation of Appomatox Court-house on the latter date. On July 10, 1866, while on duty at Willett's Point, he was made full Captain of Engineers, and in the following September was detailed as Assistant Engineer in the improvement of the Western rivers, other than the Ohio, serving until the following June. From that date until October of the same year he was engaged in

surveying a railroad route from Fort Riley to intersect the Union Pacific route at the one hundredth meridian.

He served as Chief Engineer of the Department of Missouri from Dec. 17, 1868, to May 8, 1869, and as Superintending Engineer of the defenses of New Orleans, and of various surveys and improvements of rivers, harbors and canals in Mississippi, Louisiana and Texas since June, 1869. In 1872 he made an examination of the mouth of the river Brazos for the Houston & Great Northern Railroad, the only civil service of importance in which he was engaged. He devised a plan for a ship canal to connect the Mississippi River with the Gulf of Mexico, and himself served on the committee to examine it. The plan was set aside, however, for that of Mr. Eads. The work of improving Galveston Harbor was under his charge, as was also that of devising protection for the New Orleans wharves. Major Howell's body will be taken to his home at Goshen, Ind., for burial.

RECENT INVENTIONS.

A new apparatus for facilitating the lubrication of journals running in boxes, and excluding foreign substances from the oil-duct leading to the journal, consists of the following arrangements of parts, viz.: a chamber for the inclosure of the duct, closing devices constructed in the substance of the journal itself, having communication from its bottom part by an opening with the journal itself, the walls of which chamber constitute a guide for the movement of a plug and spring which operates the same, to close the external port of such chamber. The chamber is provided at its upper part with means for retaining in position over the top of the plug a centrally perforated plate, combined with a plug having a conical head fitted to co-operate with and close the perforation of said plate on its under side actuated by a spring, both spring and plug being confined within said chamber.

A novel air-compressor comprises a cylinder and piston, and a discharge-valve provided with means for balancing it when working under a pressure not materially in excess of that desired, but which will have an access of pressure upon its face and remain open when the desired pressure is exceeded. The discharge-chest and the discharge-valve is subjected to the action of compressed air upon both sides.

A novel means for utilizing secondary batteries on telephone circuits comprises a main line, which includes a secondary battery; an independent branch circuit, which includes the secondary coil of an induction apparatus of a telephone transmitter; a sub-circuit normally held open by the weight of the telephone, which circuit includes the secondary battery and the primary coil of said induction apparatus; switch devices for excluding the secondary battery from the main line and completing the main line through the branch circuit, which includes the secondary coil of the transmitter, and switch devices for completing the sub-circuit when the telephone is removed from its support.

A late improvement in water-closets consists of a bowl forming one leg of a trap, a second trap below the first, an exhaust pipe leading from the air space between the two traps and terminating near the top of the flushing chamber, the latter being provided with inlet and outlet valves, and a flushing pipe leading from the outlet valve thereof to the bowl. Means are provided for preventing further retardation of the flow of flushing water after the bowl has been siphoned by the partial vacuum formed by the descent of water in the flushing chamber, thereby augmenting the after-wash and insuring the final filling of the bowl.

A novel metallic railway tie consists of a flat plate upon which are clamps arranged longitudinally of the tie, with their body portions beneath the same, and provided with a nose projecting above the plate to engage the rail, and with a shoulder to engage a wedge which rests upon the upper surface of the plate. Adjacent to the shoulder is an overhanging lip, which extends over the wedge. The body portion of the clamps have an extended bearing surface, and are provided with elongated ends extending downwardly with laterally projecting flanges. To prevent the displacement of the wedge a fixed lug is provided upon the tie to engage with ratchet-shaped teeth upon the wedge.

A new fire escape ladder is pivoted to the journal of the wheel of the truck for adjusting the angle of the ladder and which has an opening through the same for the ladder to pass sideways. A chamber containing compressed air is secured to the lower part of the apparatus containing a cylinder and piston. The flow of air into the cylinder is controlled by a valve, and assists in elevating the ladder.

The novel elements of an improved drilling machine consist of a supporting frame carrying a fixed drill-shaft, and a circularly movable drill-shaft, and a device for rotating both shafts simultaneously.

A late improved self-acting elevator safety apparatus consists of latches pivoted upon the sides of the elevator shaft or frame, and adapted to engage projections or recesses in the cage, with a spring brought into play by the tension thereon of the main rope under the weight of the elevator suspended therefrom. Intermediate cords are employed by which the spring, when relieved from tension, will be made to act upon the latches, and throw them into effective engagement with the elevator to engage to arrest and support it.

WASHINGTON, D. C. F. B. BROCK.

THE HISTORY AND STATISTICS OF AMERICAN WATER-WORKS.

BY J. JAMES R. CROES, M. AM. SOC. C. E.

Continued from page 100.

CCLXI.—OAKLAND.

Oakland, California, in lat. 37° 30′ N., long. 122° W., on the Bay of San Francisco, is on flat, low, sandy ground. Back of the city are hills rising to a height of 1,500 ft. Settled in 1851, it was incorporated as a city in 1854. Water-works were built by a private company in 1866, after the plans of Anthony Chabot. The supply is taken from San Leandro and Senescal creeks, on which impounding reservoirs are created by earth dams. The San Leandro Lake drains 44 square miles, covers 400 acres, and contains 2,570,057,424 gallons at 200 ft. above the city. The dam is 80 ft. high and 300 ft. long, and 310 ft. wide at the base. The Senescal Lake drains 5 square miles, covers 18 acres, and holds 300,000,000 gallons at 400 ft. above the city.

A 24-in. riveted wrought-iron pipe, coated with asphalte, conveys the water from San Leandro to a distributing reservoir in the city holding 1,000,000 gallons, and two smaller reservoirs on the edge of the city. At the lake outlet the water is passed through screens formed of cotton cloth tacked on frames. Distribution was by wrought-iron, cement-lined pipe until 1878, when some cast-iron pipes were laid. The boiler-iron riveted pipe, coated with asphalte and lined with cement, is preferred; 123 miles of pipe are laid, with 195 fire hydrants, 730 gates and 5,300 taps; 102 meters are in use. The city does not pay for use of fire hydrants.

Service pipes are of galvanized iron.

The population in 1880 was 34,556 and the daily consumption from 5,000,000 to 7,000,000 gallons. The water is used extensively in the dry season for irrigation and for flushing sewers.

The capital stock of the company is $3,000,000. The works have cost to March, 1882, $3,961,644.75, and the gross receipts for water hav been $1,356,793.78. There is a bonded d bt of $495,000, at 8 per cent. The expenses in 1880 for maintenance and extensions were $167,458.84 and the receipts $202,933.28.

A. Chabot has been the President and Engineer from the beginning, and owns a controlling interest in the stock. Wm. H. Medd is the Secretary.

CCLXII.—TOWN OF LAKE.

The Town of Lake is a suburb of Chicago on level ground on the shore of Lake Michigan. Settled in 1860, it was incorporated as a town in 1867. Water-works were built in 1874 by the town, after the plans and under the superintendence of J. T. Foster.

The supply is taken from Lake Michigan through 1,750 ft. of 30-in. cast-iron pipe, and pumped directly into the mains by Holly quadruplex pumps of 9-in. bore and 24-in. stroke, and a Knowles pump of 20-in. bore and 36-in. stroke. The ordinary pressure is 20 lbs. and the fire pressure 60 lbs. per square inch.

Distribution is by 52 miles of cast-iron pipe of from 16 to 3-in. diameter, with 309 fire hydrants, 360 gates, 3,000 taps and 68 meters. Lead service pipes are used.

The population in 1880 was 15,716, and the daily consumption three million gallons.

The works have cost $1,000,000 and the receipts have been $160,000. The bonded debt is $237,000. The expenses in 1880 were $5,000 and the receipts $30,000. J. T. Foster is the Superintendent.

CCLXIII.—HENDERSON.

Henderson, Kentucky, in lat. 37° 53′ N., long. 87° 37′ W., is on gently undulating ground on the east bank of the Ohio River. Settled in 1797, it was incorporated as a town in 1810 and as a city in 1867.

Water-works were built by the city in 1874–5, after the plans of Thomas J. Whitman, C. E., and under the superintendence of Gaston M. Alves, C. E.

The supply is taken from the Ohio River and pumped by a beam and fly-wheel engine with steam cylinder of 20-in. and two single acting plunger pumps of 14½-in. diameter, all of 60-in. stroke, into a reservoir built in excavation and embankment, lined with 2 ft. of clay puddle covered with 9 in. brick masonry on slopes and concrete on the bottom, 20 ft. deep and holding 3,000,000 gallons at 85 ft. above the business part of the town.

An air-chamber on the pump suction prevents thumping. A wrought-iron stand pipe on the reservoir bank, 5 ft. in diameter and 80 ft. high is designed for use for fire pressure, but is little used.

Distribution is by 7¼ miles of cast-iron pipe of from 12 to 3-in. diameter, with 47 fire hydrants, 35 gates and 347 taps. Service pipes are of galvanized iron.

The population in 1880 was 6,573, and the daily consumption 150,000 gallons.

The works have cost $125,000. The bonded debt is $100,000 at 6 per cent. and $13,500 at 5 per cent. interest. The expenses in 1881 were $2,500 and the receipts $5,500. The surplus revenue is devoted this year to pipe extensions. The works are managed by 5 commissioners appointed by the City Council. Fred. Kliederer is the Secretary and Treasurer and Gaston M. Alves the Civil Engineer.

CCLXIV.—VANCOUVER.

Vancouver, Washington Territory, in lat. 45° 31′ 50″ N., long. 122° 27′ 30″ W., on the north bank of the Columbia River. Along the river the ground is level, with a rolling upland back of it. Settled in 1850, it was incorporated as a city in 1868. Water-works were built by a private company in 1868, after plans of August Shaben and Lewis Myers, taking the supply from copious springs and collecting the water in a reservoir holding 500,000 gallons, and formed by constructing a timber dam 7 ft. high and 100 ft. long across a ravine. A wooden pipe of 5½-in. diameter conveys the water 3¾ miles to two brick reservoirs holding respectively 30,000 and 500,000 gallons, built near the city and 90 ft. above it.

Wooden pipe was first used for distribution, but has been replaced by a 4-inch cast-iron main from the reservoir, and wrought-iron of 2-in., 1½-in. and 1-in. diameter in the city. Ten miles are laid, with 6 fire hydrants, 6 cisterns, 10 gates and 175 taps.

The population is 1,700 in the city and 500 in the military post. The consumption is not known.

The works have cost $50,000. The expenses in 1880 were $2,000. No further financial statements are given. J. R. Wintler is the Superintendent.

(TO BE CONTINUED.)

ACKNOWLEDGEMENTS.—The receipt of statistics as follows is acknowledged with thanks: From Wm. G. Richards, superintendent, report of the water-works of Atlanta, Ga., for Dec. 31, 1881. From E. Jacoby, superintendent, statistics and water rates of the water-works of Bloomsburg, Pa. From F. W. Meeker, secretary, report for 1881 of the Newark, N. J., Aqueduct Board. From R. B. Wallace, superintendent, statistics of the water-works of Lafayette. Ind. From S. B. Bowman, superintendent, statistics and water rates of the water-works of Berwick, Pa. From Wm. H. Medd, secretary, statistics and water rates of the water-works of Oakland, Cal. From Samuel L. Brooks, superintendent, statistics and water rates of the water-works of The Dalles, Oregon. From J. R. Wintler, superintendent, statistics and water rates of the water-works of Vancouver, Wash. Ter. From Fred. Kleiderer, secretary, and Gaston M. Alves, C. E., statistics of the water-works of Henderson, Ky. From J. T. Foster, superintendent, statistics of the water-works of the Town of Lake, Ill. From T. A. Ellis, city engineer, 8th report of Water Commissioners and 13th report of Street and Sewer Commissioners of Springfield, Mass.

CORRECTIONS.—March 25. *Salem*, Oregon, has 7 miles of pipe, instead of 6.

Pioche, Nevada, has 5¾ miles of pipe, instead of 8.

April 1, p. 106. *Chelsea*, 5th line from end, for *Charles River* read *Mystic River*.

CORRECTION.—In your report of Atchison Water-works, the Superintendent failed to mention my name, although the franchise was granted to me by the city, and I engineered the work and contracted with the company to do, and did, all of the work. The specifications only were made by Mr. Whitman. The whole scheme, from beginning to end, was engineered and controlled by me individually, and I assume all responsibility in connection therewith. S. WATTS.

A PRODUCER'S CLASSIFICATION OF IRON AND STEEL.*

The classification of iron and steel proposed by the German Railway Union† as a basis for the supply of railway material having given rise to considerable discussion among the producers of such material, a commission for the purpose of drawing up a revised scheme was formed by the Society of German Ironmasters; and at a general meeting held at Düsseldorf on May 28, 29, 1881, was adopted after discussion. The commission deprecated

* *Stahl und Eisen*, vol. i., p. 1; through *Minutes of Proceedings of the Institution of Civil Engineers.*

† See *Minutes of Proceedings Inst. C. E.*, vol. lxv., p. 436.

the practice of using the contraction of the fractured area alone as a principal measure of the toughness of the material, and considered that evidence of greater practical value as to this property is to be obtained from the results of the falling weight and bending tests combined. After some preliminary instruction in the method of preparing test pieces, the classification of the tests is given as follows:

(I.) TESTS WITH UNDIVIDED OBJECTS.

a. Cold tests. 1, External inspection; 2, hammering; 3, falling weight; 4, direct loading. *b.* Hot tests.

(II.) TESTS WITH SEPARATED PIECES.

a. Cold. 1, Bending; 2, punching; 3, breaking; 4, tensile. *b.* Hot. 1, Bending; 2, punching; 3, forging; 4, welding.

The standards for the different classes of material are:

1. HOMOGENEOUS MATERIAL (STEEL). A. RAILS.

a. Inspection.—As permissable variations in the linear dimensions, ± 3 millimeters in length, + ½ millimeter in height, and ± 1 millimeter in breadth of flange.

b. Falling Weight.—Tests to be applied to rail pieces that have not been either notched or bored, and whose ends do not project more than ⅙ meter beyond the bearings. The heights of fall of a weight of 600 kilograms, fixed for rails of different sections, are:

a. Weighing above 30 kilog. per meter and about 130 mm. high, 5 meters.
b. Weighing 27½—30 kilog. per meter and about 120 mm. high, 3.25 meters.
c. Weighing 23—27 kilog. per meter and about 110 mm. high, 2.5 meters.
d. Weighing 20—24 kilog. per meter and about 100 mm. high, 2 meters.

The test-piece, 1 meter long, between the points of support in each case to receive two blows without fracture.

c. Loading Test.—For the different sections and weights given above, the weights to be supported without producing more than ⅙ millimeter permanent deflection, are:

a. 17,500 kilograms; b. 13,500 kilograms; c. 11,500 kilograms; d. 10,000 kilograms.

d. Bending Test.—A length of rail, 1 meter, between the points of support to bend to 50 millimeters over both head and foot without fracture.

B. TESTS WITH PREPARED TEST PIECES.

a. Tensile Test.—Under the assumption that either the contraction of area or the longitudinal extension, but not both, will be used in judging the quality of the material, the commission recommend the following tests:

Bars of 200 millimeters long and 20 millimeters diameter shall bear a minimum load of 50 kilograms per square millimeter, with a contraction of 20 per cent. or an elongation of 12 per cent.

As regards further conditions in contracts for supplying rails, the commission remark as follows:—

1. As limits of toleration in weight, 3 per cent. above and 2 per cent. below the normal amount, and of the excess weight about 2 per cent. should be paid for.

2. As regards maximum length, 9 meters, beyond which very few rolling mills are capable of working, and the risk of damage in transport is greatly increased.

3. About 5 per cent. of the rails shorter than the standard length to be received.

4. The guarantee for rails is fixed at five years, commencing on the 1st of January next following the date of delivery.

5. Rails worn out in regular traffic not to be replaced under the guarantee. The guarantee on rails replaced to terminate at the same date as that on the original contract.

The number of rails reserved for testing not to exceed ½ per cent. of the whole amount.

2. STEEL TIRES.

a. Falling-Weight Test.—To endure three blows of a weight of 600 kilograms, falling 5 meters, without fracture.

Tensile test, with pieces 350 millimeters long and 20 millimeters thick.

1. Locomotive tires. Tensile strength, 55 kilograms; contraction, 25 per cent.; elongation, 12 per cent.

2. Tender and wagon tires. Tensile strength, 45 kilograms; contraction, 35 per cent.; elongation, 18 per cent.

The guarantee of two years not to be extended to tires subjected to the action of brakes, or to those worn out in regular traffic. The toleration in dimensions to be 1 millimeter per meter diameter. The number of tested pieces not to exceed ½ per cent. of the whole.

3. STEEL AXLES.

a. Falling-Weight Test.—To support without fracture upon a length of 1.5 meter between the bearings, six blows from a weight of 600 kilograms, as follows, the point of impact being changed after each blow:

Two of 4 meters drop; two of 4½; one of 5 meters; and one of 6 meters.

b. Tensile Test.—Maximum strength, 45 kilograms per square millimeter; contraction, 28 per cent.; extension, 15 per cent. Guarantee four years against failure through defective material or manufacture. Number of tests not to exceed ½ per cent. of total.

4. STEEL SLEEPERS.

a. Cold Bending Test.—When flattened by moderately heavy blows of a steam hammer to stand bending round a radius of 75 millimeters to a loop without fracture. This test is only to be used when the form of the sleeper permits.

b. Tensile Test.—As for axles, with 30 per cent. contraction, or 15 per cent. elongation.

Permissible variation in weight, 3 per cent. above and 2 per cent. below standard; and in length, for cross sleepers, 15 meters; for longitudinal sleepers the same as for rails. Number of tests not to exceed ½ per cent. of the whole, which is that adopted by the Rhenish Railway. Period of guarantee, two years.

5. STEEL FISH-JOINT AND BEARING PLATES.

The tensile strength to be the same as for rails, but having regard to the great variety in the form of these articles in use the general application of other tests does not seem to be desirable.

C. STEEL CONSTRUCTIVE MATERIAL.

As sufficient experience in the use of steel for constructive purposes is wanting, the Commission does not consider it possible to recommend any special series of tests. In a general way, a tensile strength of 45 to 55 kilograms, with an elongation of 15 to 20 per cent., may be considered sufficient.

D. STEEL PLATES.

1. *Ship Plates.*—The tests recommended are those adopted by the German navy, namely, a tensile strength of 40—50 kilograms per square millimeter. Annealed plates should bend cold upon a radius equal to the thickness through 180° without fracture. Plates 260 millimeters long and 40 millimeters broad, raised to a cherry-red heat, and cooled in water at 28° Cent., to bend round a radius of 1½ thickness without fracture.

2. *Boiler Plates.*—Tensile strength 38—47 kilograms per square millimeter, with an extension of 25—18 per cent. Plates when soft to bend cold through an angle of 180° upon a radius of half the thickness. When hardened to satisfy the test given for ship plates.

The above tests are applicable to plates at least 5 millimeters thick; the testing of thinner ones not being considered necessary.

II. WELDED MATERIAL. A. BAR IRON.

I. Rivet (best best) iron.

For this quality a tensile strength of 38 kilograms per square millimeter, with an extension of 15 per cent., is specified.

a. Cold Bending Test.—Pieces cut from flat bars from 30 to 50 millimeters broad, and not more than 16 millimeters thick, and round bars up to 30 millimeters in diameter, should stand bending into a loop whose inside diameter is equal to the thickness of the bar.

b. Hot Test.—When heated the test piece must bear doubling and a piece of round iron two diameters long must bear reduction to one-third of its length without cracking.

2. Horseshoe nut, or (best) iron.

Tensile strength 36 kilograms, with an extension of 12 per cent.

a. Cold Bending Test.—Flat section, not more than 16 millimeters thick, square and round, up to 30 millimeters diameter, to bend without cracking into a loop whose internal diameter is twice the thickness of the iron.

b. Hot Test.—The test piece of the dimensions previously given must bear bending into a loop whose inner diameter is equal to the thickness of the iron.

The above values for tensile strength and extensibility can only be held to apply to manufactured objects whose thicknesses are not greater than those given under the cold bending tests. If therefore it is desired to test thicker objects, the test pieces must be reduced to the proper size by forging or rolling. The standard length for test pieces is fixed at 200 millimeters.

3. *Ordinary Bar Iron.*—The commission does not consider it possible or necessary to introduce tests for this class of iron, as the differences between the make in the three principal German iron-making districts are dependent upon the local material employed, and cannot be eliminated.

B. RAILWAY MATERIAL.

1, 2, 3. Sleepers, fish-plates and bearing pieces.

The toleration in weight and dimensions to be the same as that given for steel sleepers. Up to the present time railway managers have not specified any particular quality other than fibrous iron generally. Probably a tensile strength of 34 kilograms, and 10 per cent. extensibility, will be sufficient. Should a cold bending test be required, it is proposed that test-pieces 30 to 50 millimeters broad, with rounded edges, should stand bending upon a radius of 13 millimeters as follows:

Thickness,	8—11	millimeters,	50°
"	12—15	"	35°
"	16—20	"	25°
"	21—25	"	15°

Warm tests of these articles are not considered necessary, as they are never subjected to heating in use. As experience shows that the quality of the material is not affected by punching or notching when cold, this should be permitted. The permissible variation in length to be ± 3 millimeters, and in weight ± 3 per cent. It must be remembered that these articles cannot be sawn hot, as is sometimes required, but must be cut cold with a shearing machine.

4. Small iron material. Bolts, spikes, etc.

Usually a high quality of fibrous iron is specified for these objects. A tensile strength of 35 kilograms, with 42 per cent. extension, should be sufficient. The cold and warm bending tests should be the same as for best iron.

C. PLATES.

The commission consider it sufficient to lay down bending and tensile tests for the three best qualities of plates, leaving it to the consumer and producer to distinguish these by particular names. It is to be remarked that many of the names hitherto used are no longer applicable, for instance, so-called charcoal plates are not now made from charcoal iron, etc. A general recognized classification, which should as far as possible express the quality, is much to be desired. The following are the tests recommended:

(I.) WITH ENTIRE OBJECTS.

Inspection.—Each plate, when examined on both sides, is to be free from blisters, cracks, and other marks of defective rolling; surfaces to be smooth and uniform. In dimensions a variation of ± 10 millimeters in length and breadth. The weight to correspond to that form by calculation to within + 5 per cent. in single plates, and ± 3 per cent. in larger quantities.

(II.) WITH PREPARED TEST-PIECES.

a. Bending Tests.—The hot bending test to be round a square edge; the cold ones round a cylinder 26 millimeters in diameter. The angles through which the plate must bend red hot are, for:

	No. III.	No. II.	No. I.
With the fiber, . .	110°	150°	180°
Across " . .	80°	120°	180°

COLD BENDING TESTS.

Thickness.	No. III.		No. II.		No. I.	
	Longitudinal.	Transverse.	Longitudinal.	Transverse.	Longitudinal.	Transverse.
Millimeters.	°	°	°	°	°	°
6— 7	50	30	80	50	110	90
8— 9	45	25	70	40	100	80
10—11	40	20	60	35	90	70
12—13	35	15	50	30	80	60
14—15	30	12	40	25	75	50
16—17	25	10	35	20	70	40
18—19	20	8	30	15	65	35
20—21	15	5	25	10	60	30

The test is to be considered broken when a visible fracture appears in the metallic iron.

b. Tensile Tests.—The cuttings removed from the dome, man hole or fire-tube plates to be used where possible. Fire-box and certain shell plates to be ordered 50 millimeters larger than the dimensions required, to allow the test pieces to be cut from them. The choice of length of the rectangular test piece between 150 to 200 millimeters, and of the section between 300—600 square millimeters, to be left to the maker. The values in the following table, in kilograms, are the breaking strain per square millimeter of the original section. The extension is to be measured after fracture. The numbers given for strength and extensibility may vary by one, but the sum of both must be equal to that of the table.

	No. III.		No. II.		No. I.	
	Longitudinal.	Transverse.	Longitudinal.	Transverse.	Longitudinal.	Transverse.
Tensile strength, kgms	33	30	35	33	36	34
Extension (per cent)	7	5	12	8	18	12

The values given above are those adopted by the German Steam Boiler Inspection Commission at the meeting at Wurzburg, Feb. 10, 1881.

D. CONSTRUCTION IRON.

By this term is meant the quality of rolled bar iron used in the construction of bridges and other large works.

A. TESTS WITH UNDIVIDED OBJECTS.

1. *Inspection.*—The iron must be properly rolled with smooth even surfaces, and free from cracks and cinder patches and other surface defects.

2. *Fracture.*—A flat bar, when nicked with a chisel and bent, must show a mainly fibrous structure, except in the case of bolt or rivet iron, where a fine-grained fracture may be required.

All further tests with full-sized objects are to be

avoided, either as being inapplicable or because the information required may more readily be obtained by working upon prepared test pieces. The hot bending test sometimes specified for flat and angle iron bars, of requiring the full sized bar to bend hot through a certain angle, is uncertain, as the result depends mainly upon the skill of the operative making it; a good smith may apply it successfully to an inferior quality of material, while an unskilled one may fail with a better class of iron. The existence of redshortness, which this is intended to detect, may be more readily determined by the hot test upon prepared pieces.

B. TESTS WITH SEPARATED PIECES.

According to its uses, iron for constructive purposes may be divided into the following four classes (I. to IV.) each corresponding to a particular requirement or a particular method of manufacture.

I. For angle and flat bars and plates mainly subjected to strain in one direction.

The plates included in this class are those employed in the tables of girders, tension rods, compression struts, etc.

1. *Cold Bending Test.*—A strip from 30 to 50 millimeters broad must bend, without fracture, round a cylindrical surface of 13 millimeters radius, through an angle varying with the thickness of the plate. These angles are the same as those already given for sleepers and fish-plates. This method of bending is to be preferred to the custom of bending into a loop of large radius more generally practiced, as it may be applied mechanically in a more uniform way than can be done when the result depends in part upon the skill of the operator.

2. *Tensile Test.*—Longitudinal breaking strain, 36 kilograms per square meter: extensibility, 12 per cent.; the test pieces to be from 300 to 500 millimeters long in the extensibilities to be observed upon a length of 200 millimeters.

These figures to apply only to bars whose thickness does not exceed 16 millimeters. Heavier bars should, as a rule, be avoided for such uses. When it is required to test the material of thicker bars, the test must be reduced to the standard dimension by forging or rolling.

3. *Hot Bending Test.*—Strips of the same dimensions as those of the cold bending test, when similarly treated at a cherry-red heat, must bear through the following angles, according to thickness: up to 25 millimeters, 120°; above 25 millimeters, 90°.

2. *Forge Test.*—A strip of a flat or angle bar or plate, cut cold and heated to redness, must extend under the hammer to one and a half time its original breadth, without showing signs of separation in the iron. The radius of the hammer pane to be 15 millimeters.

II. Plates that are subjected to strains in different directions, or mainly to bending strains.

This includes connecting plates, corner pieces, gussets, the web-plates of girders, etc. The cold bending test for these, in the direction of the fiber, is similar to that for the preceding class. Across the fiber the angles are according to thickness—8 to 11 millimeters, 20°; 12 to 15 millimeters, 15°; 16 to 20 millimeters, 10°; 21 to 25 millimeters, 5°.

2. *Tensile Test.*—When the plates are approximately square, the breaking strain is—

Longitudinal, 35 kilograms, with 10 per cent. extension.

Transverse, 30 kilograms, with 4 per cent. extension.

As these plates are mainly used as connecting pieces, the tensile strength may be taken 1 kilogram lower than in group I., as the constructor has to work mainly by the lower strength in the transverse direction. For the same reason the extensibility may be reduced from 12 to 10 per cent. When the length of the plate is much greater than the breadth, the values are:

Longitudinal, 35 kilograms, with 10 per cent. extension.

Transverse, 28 kilograms, with 3 per cent. extension.

These plates are mainly applied in the webs of girders, and of cross and longitudinal bearers, whose length is at least eight times their breadth, for which purposes the transverse tensile strength of 28 kilograms is amply sufficient. The hot bending and forge tests are the same as for group I.

III. Girder iron and flooring plates.

This includes all sections differing from single angle iron, such as I T [⌐|_ bars, sash bars, etc.; also buckled, corrugated, checkered and similar plates.

Tensile tests for girders:

Longitudinal, 35 kilograms per square millimeter; extension, 12 per cent.

In this class of iron no great transverse cohesion can be expected as the pressure in rolling in such directions is but small. It is customary to use [iron for connecting pieces, on account of its convenient shape, and in such cases a transverse strength, similar to that specified in group II. should be required. This, however, cannot be obtained under the ordinary conditions of manufacture, and it is therefore preferable in such cases to use a combination of flats and angles rather than a solid section. For covering and flooring plates tensile tests are not necessary, the quality of the material being sufficiently evidenced in the manufacture. On account of their large amount of surface, their substance is more likely to suffer from rust than from loading.

IV. Rivet and bolt iron exposed to shearing strains.

To bend cold under the hammer to a loop equal to the diameter of the bar without cracking on the bend:

Tensile strength, 38 kilograms per square millimeter; extension, 18 per cent. The limits specified by the different railway authorities vary between 35 and 40 kilograms.

Hot Test.—A piece two diameters long, when heated to the proper working temperature (that of hot riveting) to bear a reduction under the hammer to one-third of its length without cracking at the edges. The commission does not consider it feasible to introduce tests for building girders, for the reasons that have been previously given under the head of common merchant iron.—H. B.

ASSOCIATION OF CONTRACTORS OF BELGIUM.

In accordance with our promise, we give below a translation of the rules of the Association of Contractors of Belgium.

Work of the Association.—The association has been formed by the various societies and clubs of contractors for public or private works in the country under the name of the "Fédération des Entrepreneurs de Belgique." The object of this association is to watch over the interests of contractors under circumstances in which the action of the various local societies would not be of much avail. It also concerns itself with the advancement of art in contract work, as well as with the perfecting of specifications both as regards their drawing up and the manner in which they shall be interpreted. It likewise takes upon itself the duty of protecting by every means in its power those contractors who may submit their complaints to its consideration, so long as they are well founded, and raise questions affecting the interests of the generality of contractors.

The headquarters of the association are fixed at Brussels.

Members of the Association.—The association is composed of ordinary members and honorary members. Those contractors who live in places where there are no contractors' societies or clubs can become members of the association on payment of an annual subscription of 24 francs (a little less than £1). All contractors belonging to any of the contractors' societies or clubs of Belgium are ordinary members. Contractors in Belgium who no longer carry on their profession, as well as contractors of other countries, can become honorary members.

General Meetings.—The members of the association must attend a general meeting, to be held the first Wednesday in May and the first Wednesday in November. The general meeting shall have unlimited powers, and take all measures that may be deemed necessary to accomplish the objects of the association. It shall fix the subscription, which shall be paid annually by each society or club adhering to the association. Resolutions shall be adopted by a majority of the votes of members present, which shall be ascertained by ballot. All societies or clubs shall have notice of the general meeting eight days previously, the societies or clubs themselves undertaking to give notice thereof to their members. The notice to the chambers or clubs shall contain a copy of the agenda to be laid before the meeting. In case of the absence of the president or vice-president the meeting shall nominate a provisional president, and in the meantime the oldest member present shall act as president.

Formation of a Council.—The association shall be represented by an administrative council. Such council shall consist of (1) a president, vice-president, secretary, assistant-secretary, treasurer, and (2) two delegates from each contractors' society or club in Belgium. The Brussels Society to have the perpetual right of sending three delegates as members of council. The president, secretary and treasurer shall form a quorum, and the council can meet and discuss questions with only these three present.

Nomination of Members of Council.—The association will annually elect members of council at the general meeting held on the first Wednesday in November. The first election is fixed for the first Wednesday in the month of May, 1882. Both candidates for election and electors must have paid all current subscriptions and moneys owing to the society or club to which they belong. If at the first voting no one obtains an absolute majority, the ballot shall begin again, and the election be decided by the relative majority; if two or more members receive an equal number of votes, the eldest of them shall be elected. The secretary shall address a letter to each member elected and not present at the meeting, informing him of his election. If the latter should neglect to notify his willingness to serve on the council within eight days from receipt of such letter, his election shall be nullified, and the council shall itself fill the vacancy.

The Rights and Duties of Members of Council.—The president is to summon and preside at each council, and all ordinary and extraordinary meetings. He shall have the sole right of summoning such meetings when he shall think proper, on receiving notice to do so from two members of the council. He shall be compelled to do so at any time on receipt of a demand to that effect signed by at least five members. Should the president refuse to summon a meeting on receipt of such demand, the vice-president shall have authority to do so. If one or more members of council, other than the delegates, shall not be present at the opening of the meetings, the president shall put other members in their places until their arrival. The president shall have supreme authority at all meetings. He shall sign all minutes, etc. All official documents and correspondents shall be addressed to the president and preserved by him. They shall be communicated to the council at the next meeting.

The vice-president shall act as president in the latter's absence; he shall keep himself informed of the progress of matters generally, and shall assist the president in everything.

The secretary shall undertake all correspondence and writing. He shall draw up the proceedings of meetings, resolutions, reports, etc. He shall, as well as the president, sign all resolutions, letters, reports, etc. He shall report each year to the general meeting on the work of the association, and such report shall be preserved in the archives. He shall take copies of all official documents, and such copies shall be deposited in the office for the convenience of members who may wish to consult them.

The treasurer shall have charge of the funds of the association as well as any invested moneys it may be possessed of. Each time that the balance of moneys in hand shall amount to 500 francs he shall inform the council of the fact, and they shall determine the mode of its investment. He shall keep a record of receipts and payments in the order of their date. He shall give receipts for all sums that shall be remitted to him. He shall not pay any moneys away excepting under an order signed by the president and one other member of council. He may, however, pay petty expenses not exceeding 10 francs without this formality on condition that he renders an account thereof to the next meeting of council. He shall twice a year lay before the general meetings a statement of accounts, accompanied by vouchers, etc. He shall keep all invoices, receipts, and such other records of money transactions as may be ordered by the council.

It may be added that M. André Hertogs is the present president of the association, and that we are indebted to him for the original copy of the above rules. We shall not attempt to criticise them here, nor to enter further into the subject at present; we leave them to the consideration of our readers. We may, however, take this opportunity of wishing all success to the Association of Contractors of Belgium and its genial president, M. André Hertogs.—*London Contract Journal.*

NOTE.—In order to reach the top of a certain plateau in Switzerland, a novel railway is in use. Its rolling stock consists of two cars, which are run up and down the incline road by a peculiar water-power. Each car has a large water-tank. The tank in car No. 1, at the upper end of the road, is filled with water, whose added weight gives the car the power as it runs down the track by gravity to pull car No. 2 from the lower end of the track to the upper, by means of a steel-wire cable, which is attached to each car and passes around a drum at the upper end of the road. When car No. 1 reaches the lower end of the road its tank is emptied, and the tank of No. 2, now at the top, is filled with water, when it in turn pulls car No. 1 to the top. A single track is used, with self-acting switches at the middle of the road, arranged so that the car going up takes one switch while the one going down takes the other, and after the cars have met and passed, each car takes the single track again.

THE RAILWAY SYSTEM OF FRANCE.—The French Minister of Public Works has published a table showing the length, earnings, expenses, profits, number of passengers and passenger miles, of tons and ton miles and receipts per passenger and per ton per mile of the whole French railroad system for the thirty-eight years from 1841 to 1879 inclusive, beginning with 358 miles and ending with 14,137. On the 8,743 miles of road reporting to the New York State Engineer and Surveyor for the year ending Sept. 30, 1880, there were 30½ per cent. more ton miles than in all France. The average passenger rates of the two countries compare as follows in cents:

	France.	New York.
Per passenger per mile.....	1.612	2.507

The average rate on passengers is 55½ per cent. higher in New York.